Claims

1. (original) A method comprising:

collecting input data from a seismic survey spread having a plurality of spread control elements, a plurality of navigation nodes, and a plurality of sources and receivers including:

navigation data for the navigation nodes,

operating states from sensors associated with the spread control elements,

environmental data for the survey, and

survey design data,

estimating positions of the sources and receivers using the navigation data, the operating states, and the environmental data;

determining optimum tracks for the sources and receivers using the estimated positions and a portion of the input data that includes at least the survey design data; and

calculating drive commands for at least two of the spread control elements using at least the determined optimum tracks.

2. (original) The method of claim 1, wherein, the estimating, determining, and calculating steps are performed by a transform function.

3. (original) The method of claim 2, wherein the positions are estimated according to a spread model within the transform function, and the optimum tracks are input to the spread model for calculation of the drive commands.

4. (original) The method of claim 3, wherein the spread model calculates a first set of estimated positions using input that includes at least the operating states and the environmental data, the navigation data includes a second set of estimated positions, and the first and second set of estimated positions are combined with the transform function to produce the estimated source and receiver positions and predicted residuals.

5. (original) The method of claim 4, wherein the predicted residuals are used to estimate a set of parameters that characterize the spread model, and the spread model parameters are used to calibrate the spread model.

6. (original) The method of claim 4, wherein the predicted residuals are use to estimate error states for sensors used to collect the environmental data.

7. (original) The method of claim 2, wherein the optimum tracks are determined according to a weighting function within the transform function, wherein the weighting function receives as inputs the survey design data and the estimated positions.

8. (original) The method of claim 1, further comprising validating the calculated drive commands and delivering the validated drive commands to the spread control elements, whereby a desirable survey objective may be attained.

9. (original) The method of claim 1, wherein the drive commands include commands for controlling at least one of the vessel propeller, vessel thruster, spread component steering devices, and the vessel cable winches.

10. (original) The method of claim 1, wherein the sensors associated with the spread control elements include one or more sensor types of tension, water flow rate, inclination, orientation, acceleration, velocity, and position.

11. (original) The method of claim 1, wherein the collected environmental data includes one or more data types of current, salinity, temperature, pressure, speed of sound, wave height, wave frequency, wind speed, and wind direction.

12. (original) The method of claim 1, wherein the survey design data is selected from spread tracks, performance specifications, and survey objectives, wherein the performance specifications are selected from drag and maneuvering characteristics for the vessel, steerable cable devices, steerable source devices, and deflectors, drag characteristic for the towed cables, sources, and floatation devices, and winch operating characteristics.

13. (original) The method of claim 1,

wherein the survey design data includes one or more data types of area, depth, area rotation or shooting orientation, line coordinates, source and receiver positions, required coverage, local constraints, optimizing factors and historical data; and

wherein the collected input data includes one or more data types of pre-survey, operator input, present survey, near-real time, real-time survey, and simulated survey.

14. (original) The method of claim 13, wherein the operator input data includes spread parameter settings and environmental data, and wherein the pre-survey data includes environmental sensor data.

15. (original) The method of claim 13, wherein the real-time survey data includes one or more data types of cable tension, water flow rate, inclination, orientation, acceleration, velocity, position, spread control element setting, environmental data, seismic signal and noise data, and operator input.

16. (original) The method of claim 13, wherein the simulated survey data includes one or more data types of simulated pre-survey, simulated operator input, simulated current survey, simulated near-real time survey, simulated real-time survey, and simulated environmental data.

17. (original) The method of claim 13, wherein the collected input data further includes raw seismic sensor data, and using the raw seismic sensor data to produce quality indicators for the estimated positions, the quality indicators selected from binning datasets, absolute noise data, signal-to-noise ratios, and seismic signal frequency content.

18. (original) The method of claim 3, wherein the spread model is a hydrodynamic force model of the spread components, a pure stochastic model of the spread components, employing one of the L-norm fitting criteria, or a neural network.

19. (original) The method of claim 18, wherein the force model contains marine current data.

20. (original) The method of claim 3, wherein the spread model is a pure stochastic model of the spread components.

21. (original) The method of claim 3, wherein the spread model employs one of the L-norm fitting criteria.

22. (original) The method claim 3, wherein the spread model is a neural network.

23. (original) A system comprising:

a seismic survey spread while conducting a seismic survey, the spread having a plurality of spread control elements, a plurality of navigation nodes, and a plurality of sources and receivers,

a database for receiving input data for controlling the seismic survey spread including

navigation data for the navigation nodes,

operating states from sensors associated with the spread control elements,

environmental data for the survey, and

survey design data,

a computer readable medium having computer-executable instructions for estimating positions of the sources and receivers using the navigation data, the operating states, and the environmental data;

a computer readable medium having computer-executable instructions for determining optimum tracks for the sources and receivers using the estimated positions and a portion of the input data that includes at least the survey design data; and

a computer readable medium having computer-executable instructions for calculating drive commands for at least two of the spread control elements using at least the determined optimum tracks.

24. (canceled)

25. (original) A method comprising:

towing a plurality of seismic survey spread elements generally behind a vessel having one or more spread control elements;

providing a first set of desired coordinate positions of one or more spread control elements, and independently measuring the coordinate positions of the spread control elements, to form a second set of actual coordinate positions;

differencing the first and second sets of coordinate positions to form residuals; and

using the residuals as set points in controllers calculating drive commands for at least one of the spread control elements.

26. (original) The method of claim 25 wherein at least one of the controllers uses a PID correction method.

27. (original) The method of claim 25 further comprising planning a path for the vessel within a constraint corridor that allows steering available in one or more towed spread control elements to achieve a target shape and track for the spread elements.

28. (original) The method of claim 25 further comprising estimating optimum tracks for tow points of towed spread control elements that provide a cross-line component relative to an optimum track for the towed spread control elements.

29. (original) The method of claim 25 wherein the first set of desired coordinate positions is provided by one or more data types selected from operating states from sensors associated with the spread control elements, environmental data for the survey, and survey design data.

30. (original) The method of claim 25, wherein each of the drive commands is used to control at least one of position, speed, and heading for the vessel.

31. (original) The method of claim 25, wherein the drive commands include commands for controlling at least one of a vessel propeller, a vessel thruster, a vessel thruster setting, a vessel propeller pitch, a vessel propeller rotation speed, a vessel rudder angle, and combinations thereof.

32. (original) A method comprising:

towing a plurality of seismic survey sources and receivers generally behind a vessel having one or more spread control elements;

estimating the positions of the sources; and

selectively activating the sources that are at the proximities of the desired cross line positions.

33. (original) The method of claim 32, wherein the number of selectively activated sources is less than the total number of sources.

34. (original) The method of claim 32,

wherein receivers are towed in a plurality of linear streamers; and

wherein the selectively activated sources form at least one linear source array parallel to the streamers.

35 (original) The method of claim 32, further comprising:

collecting input data from a seismic survey spread having a plurality of spread control elements, a plurality of navigation nodes, and a plurality of sources and receivers

estimating positions of the sources and receivers using the navigation data, the operating states, and the environmental data;

determining optimum tracks for the sources and receivers using the estimated positions and a portion of the input data that includes at least the survey design data; and

calculating drive commands for at least one of the spread control elements using at least the determined optimum tracks.

36. (original) The method of claim 32, wherein the at least one of the spread control elements is a vessel or a spread control element for a receiver.

37. (original) A seismic survey apparatus, comprising:

a vessel;

a plurality of seismic survey sources and receivers generally towed behind the vessel and having one or more spread control elements;

a controller coupled to the seismic survey sources, receivers and the spread control elements, wherein the controller estimates the positions of the sources and selectively activates the sources that are at the proximities of desired cross line positions.

38. (canceled)